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Nishikawa et al.

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(54) **WASTE-DEVELOPER COLLECTING DEVICE AND IMAGE FORMING APPARATUS INCLUDING THE WASTE-DEVELOPER COLLECTING DEVICE**

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G03G 21/10 (2006.01)

(52) **U.S. Cl.**
CPC ***G03G 21/105*** (2013.01); *G03G 2215/0129* (2013.01)

(58) **Field of Classification Search**
USPC 399/358, 360
See application file for complete search history.

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(57) **ABSTRACT**

A waste-developer collecting device includes a developing device that develops a latent image with developer, a storage section that stores the developer transported from the developing device, and a path section extending from the developing device to the storage section, and including a downward path through which the developer in the developing device flows together with air in the developing device, the downward path guiding the flowing developer downward. An opening is provided on an upper side and an upstream side of a lowermost level of the downward path so that a part of the air flowing in the path section is released out through the opening.

13 Claims, 15 Drawing Sheets

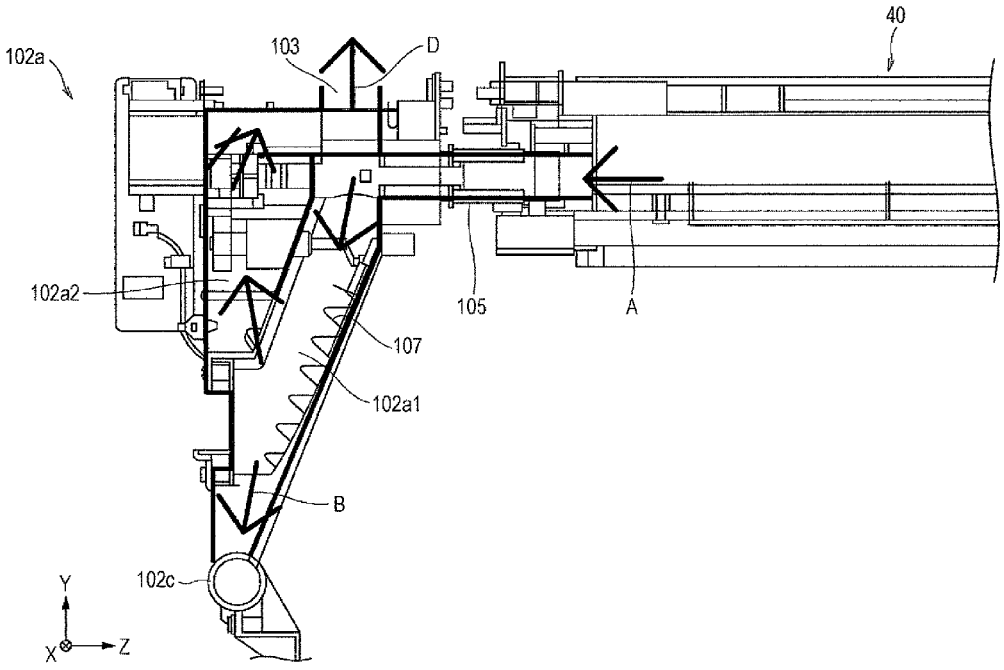
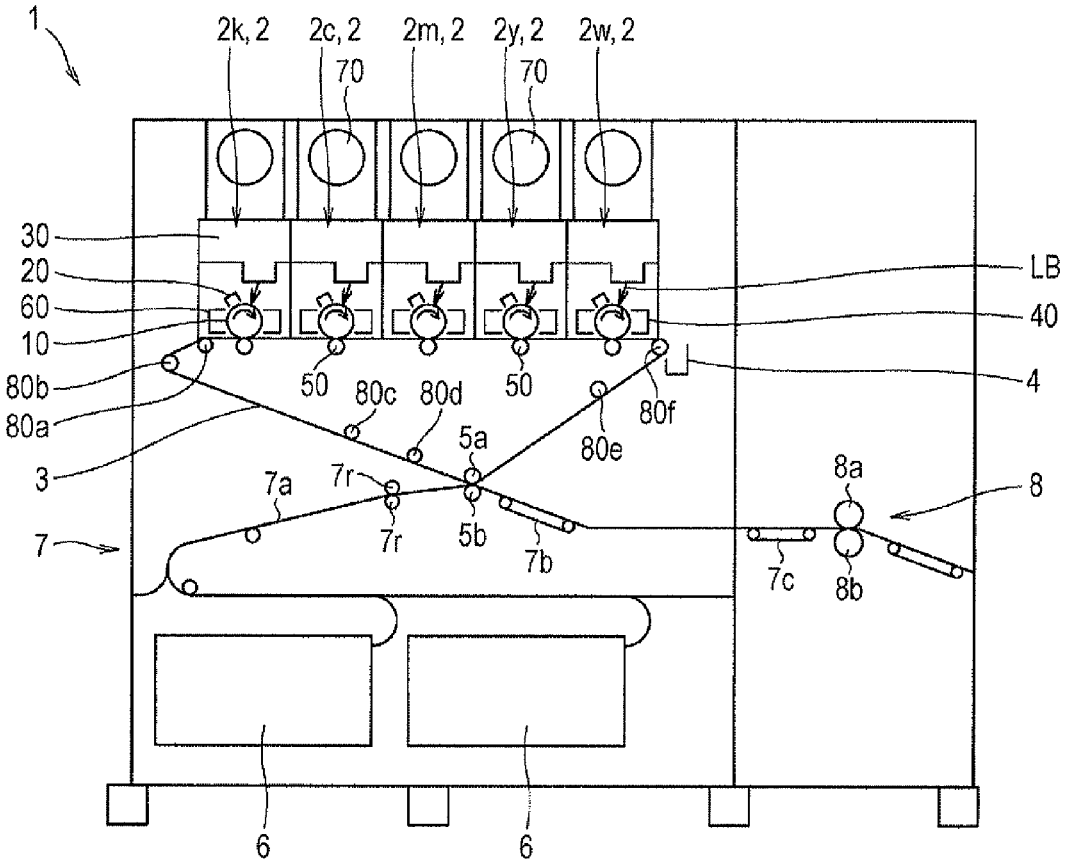


FIG. 1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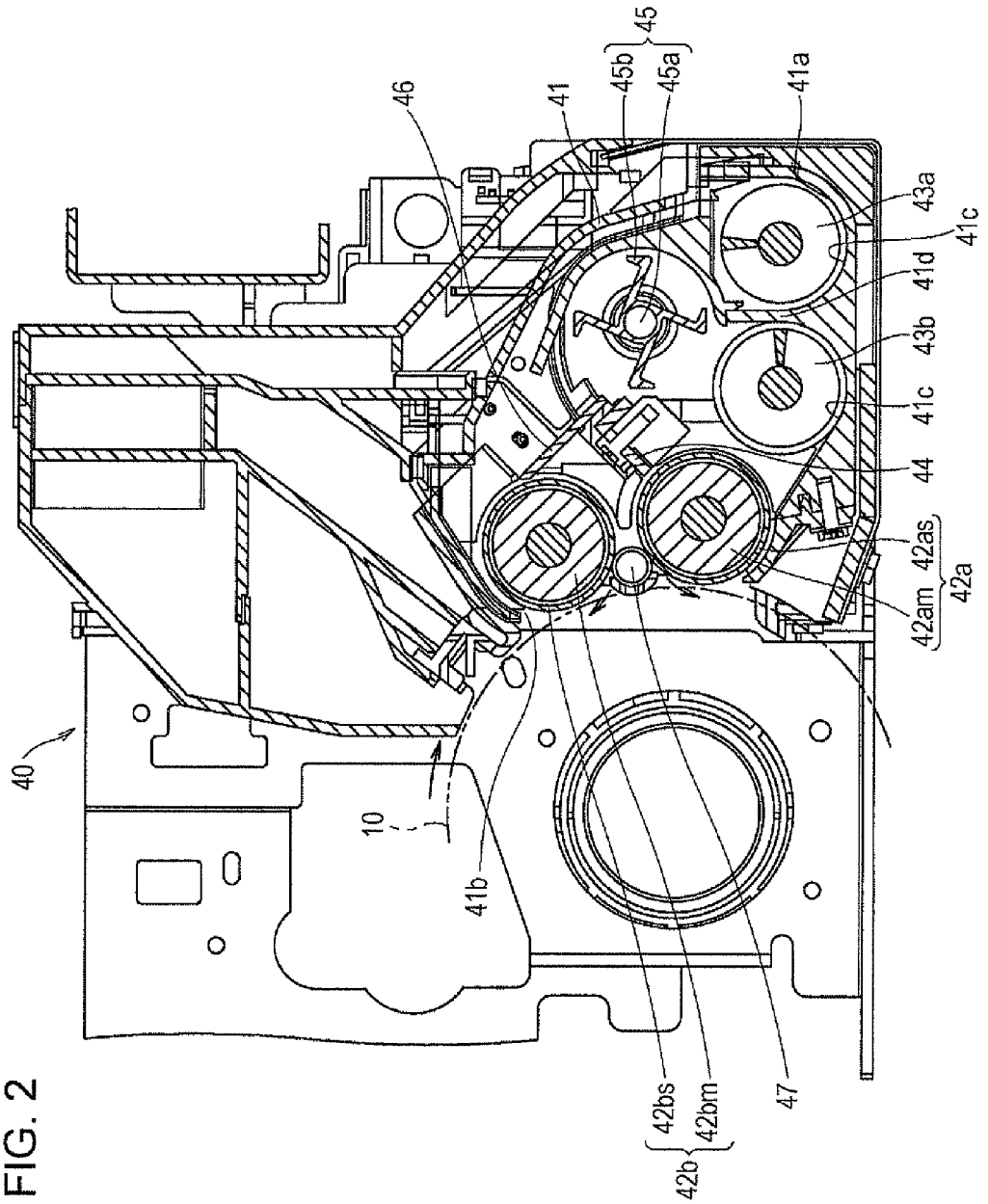
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42am
42a
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10
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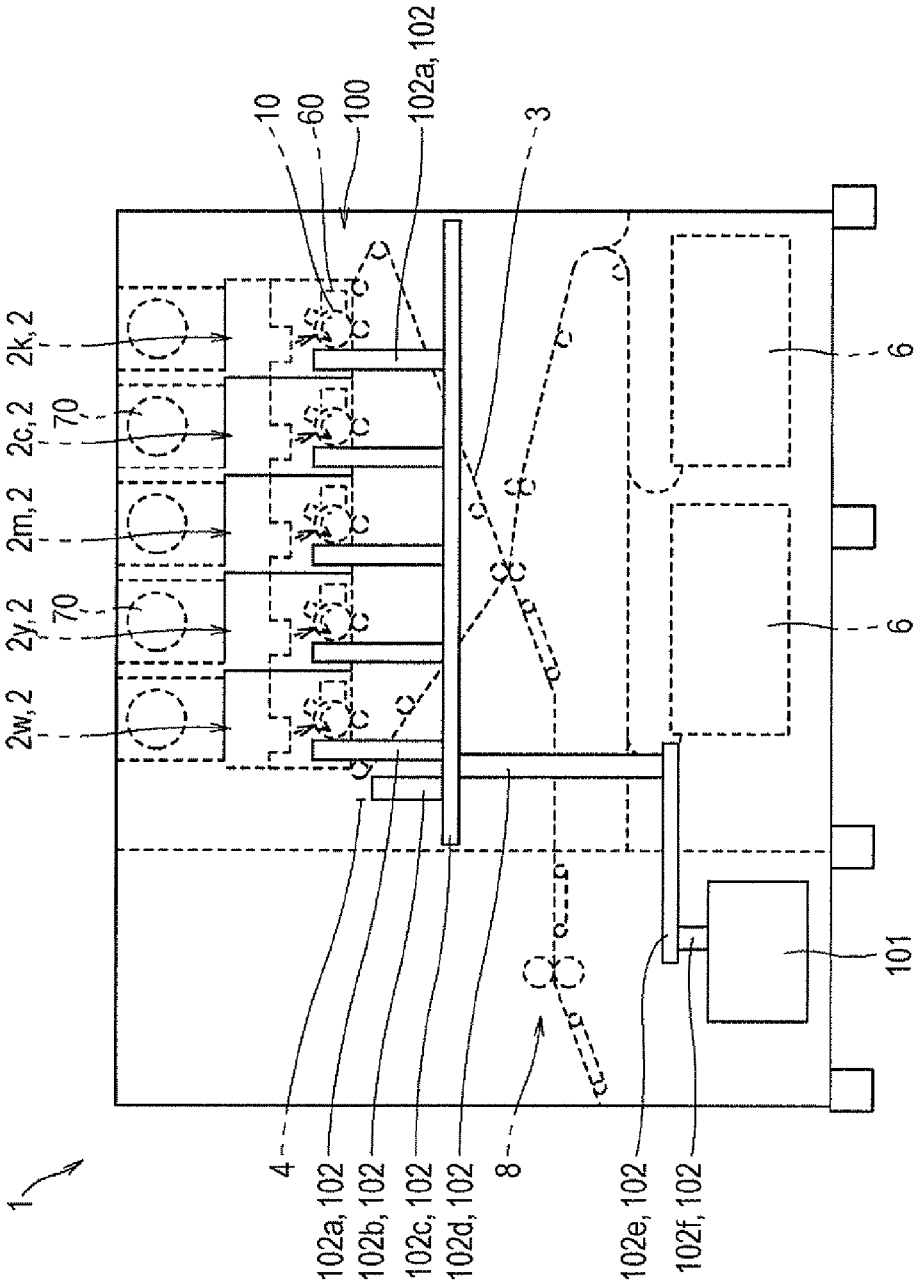
42bs
42bm
42b
47

FIG. 2

FIG. 3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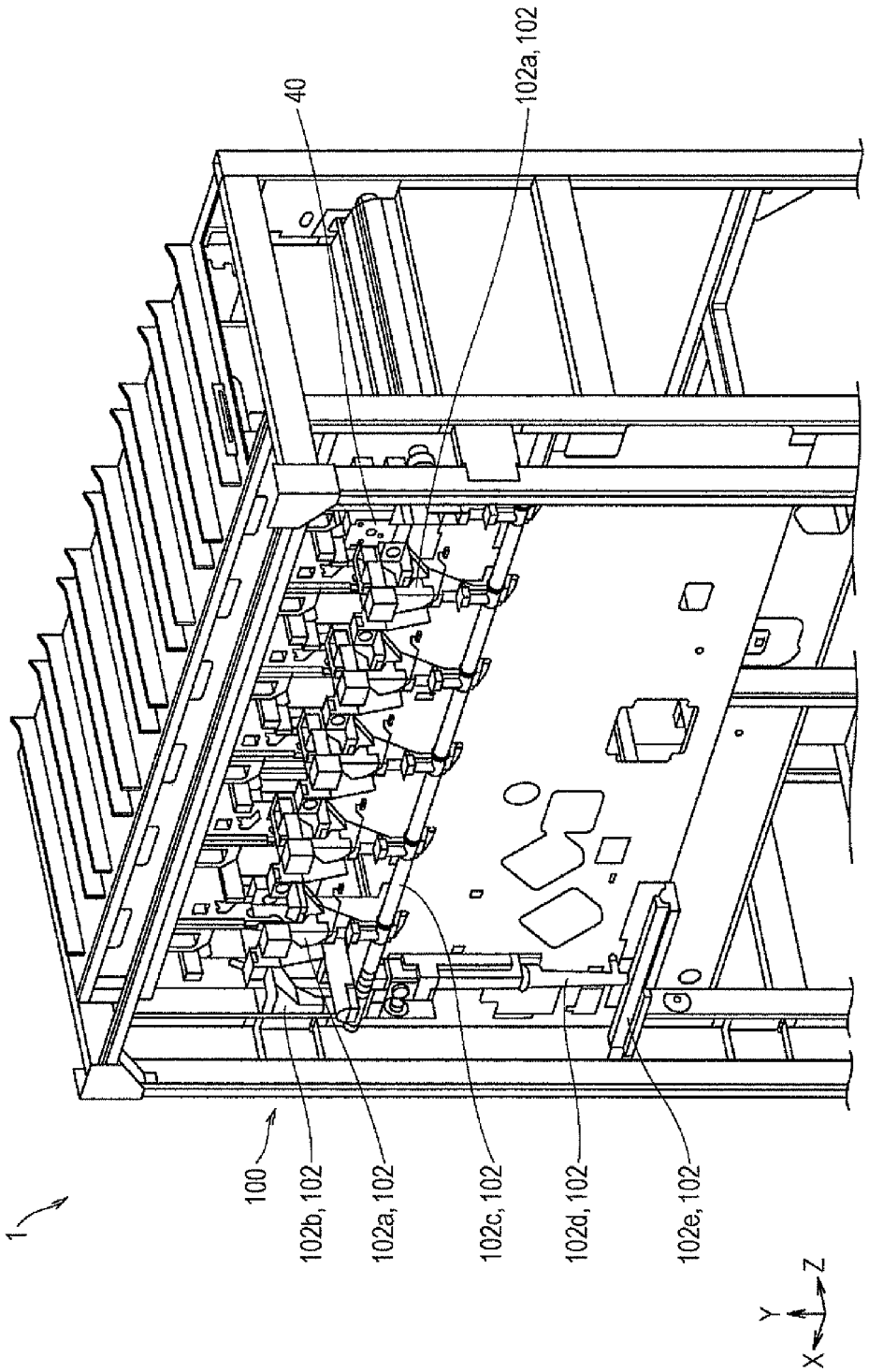
102f, 102

FIG. 4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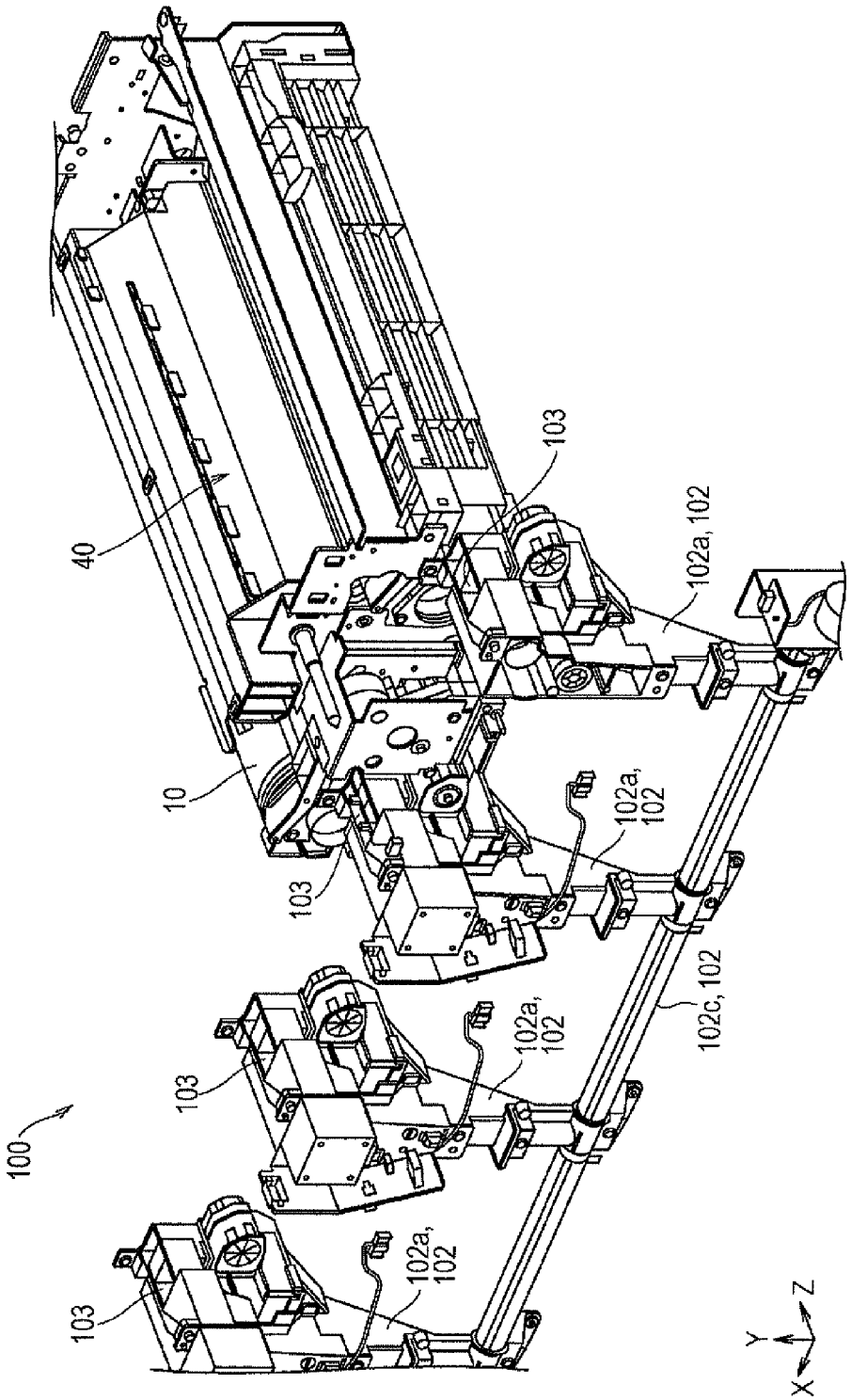
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FIG. 6

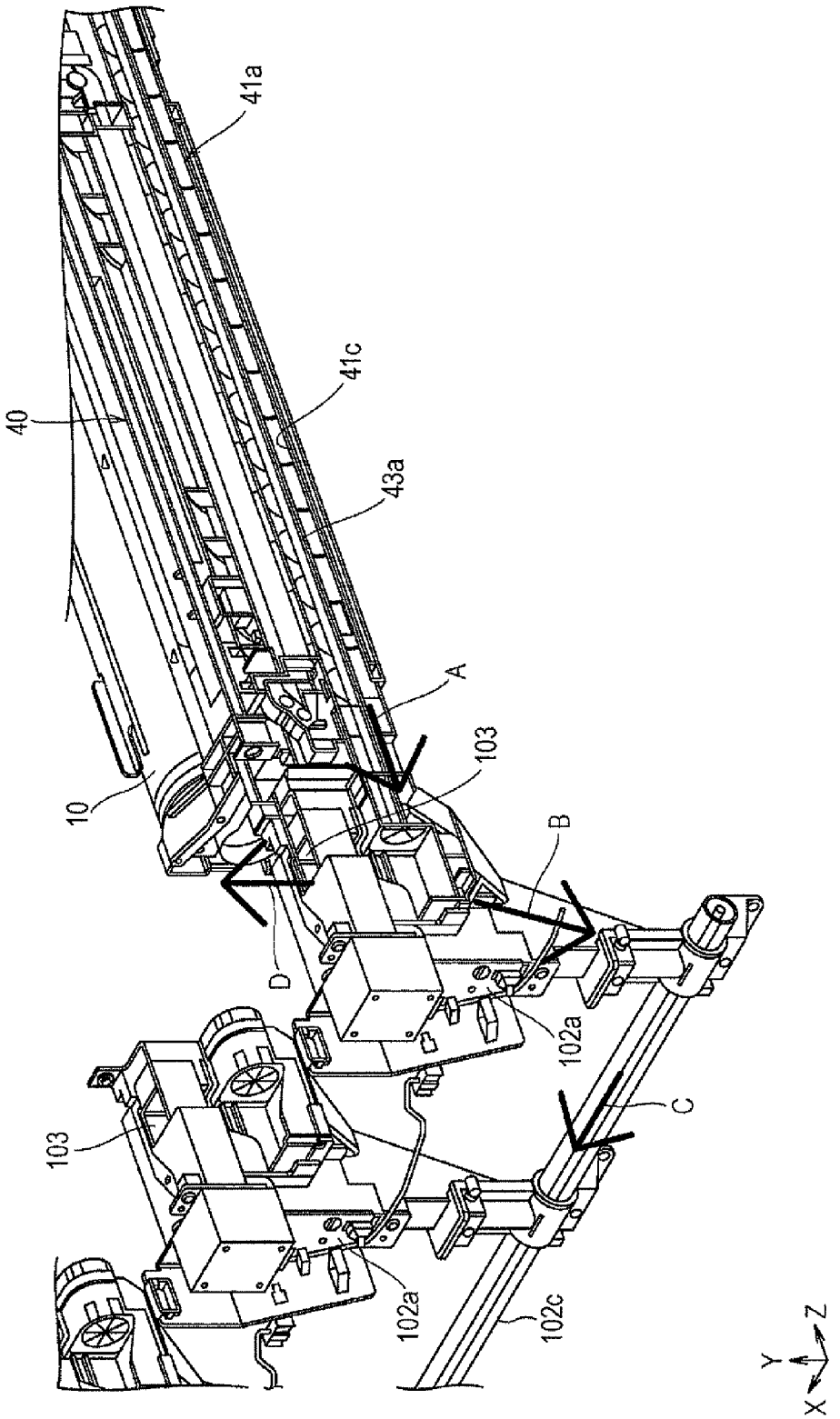


FIG. 7

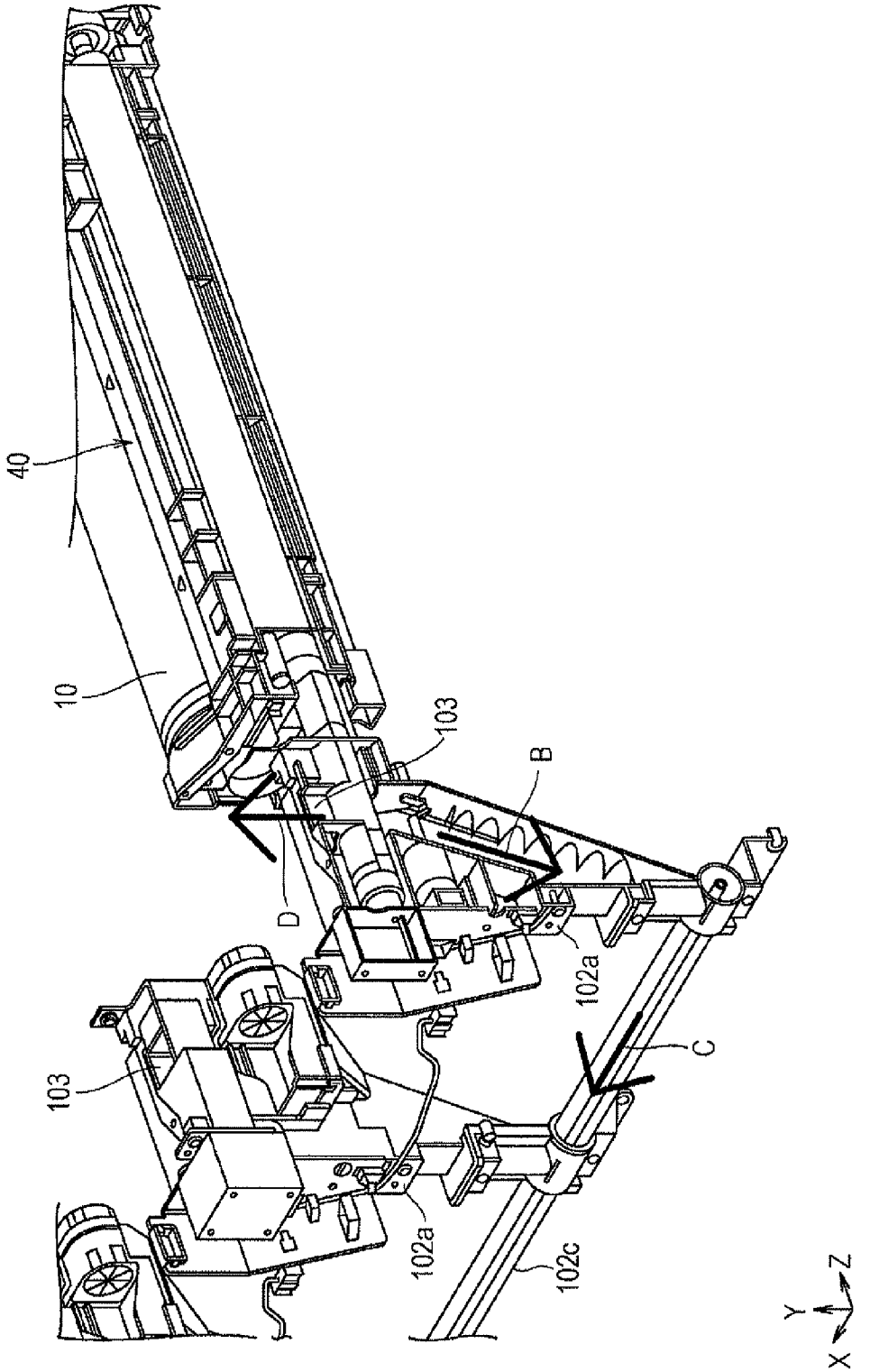
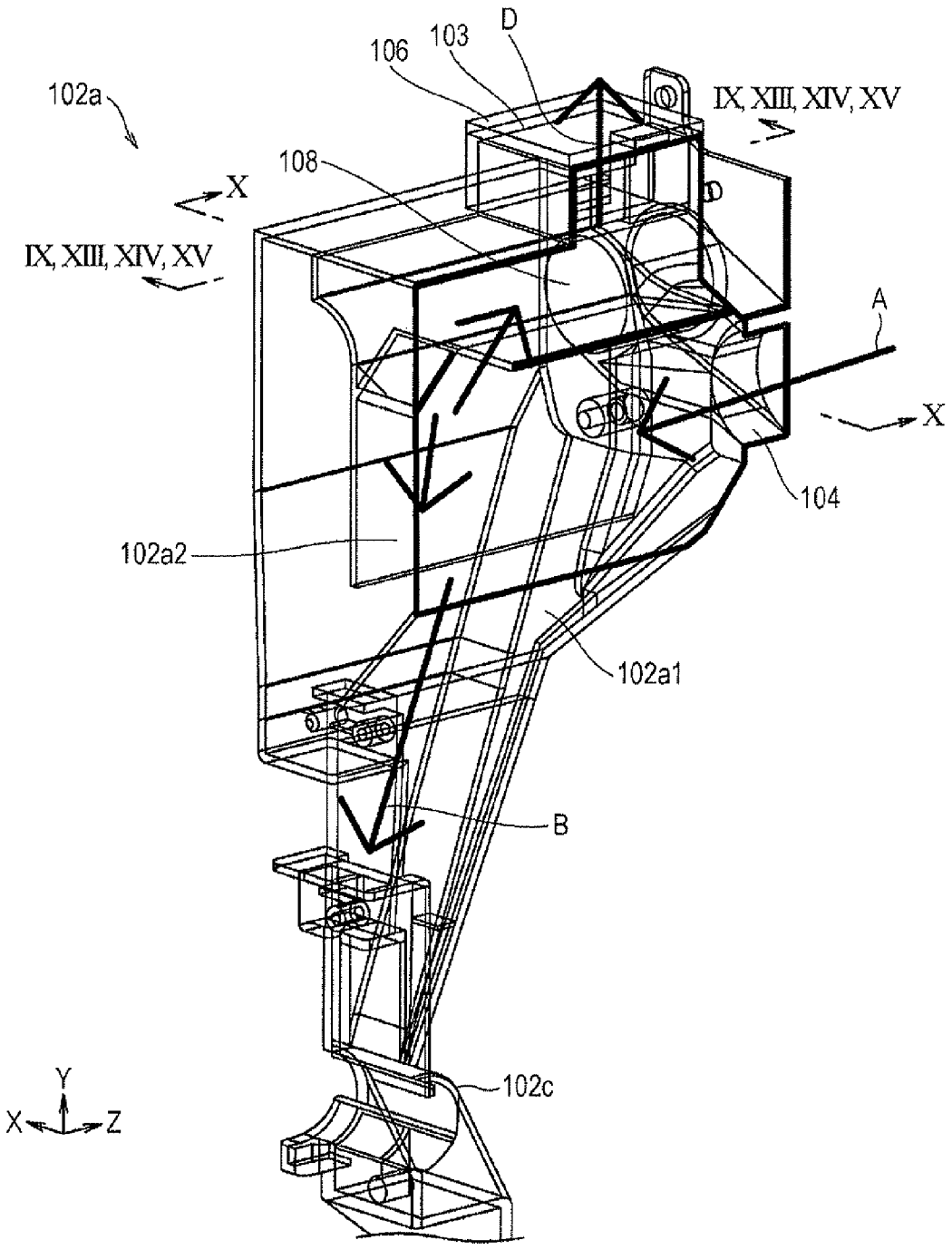


FIG. 8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103
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IX, XIII, XIV, XV
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104
102a2
102a1
B
102c
Y
X
Z

FIG. 9

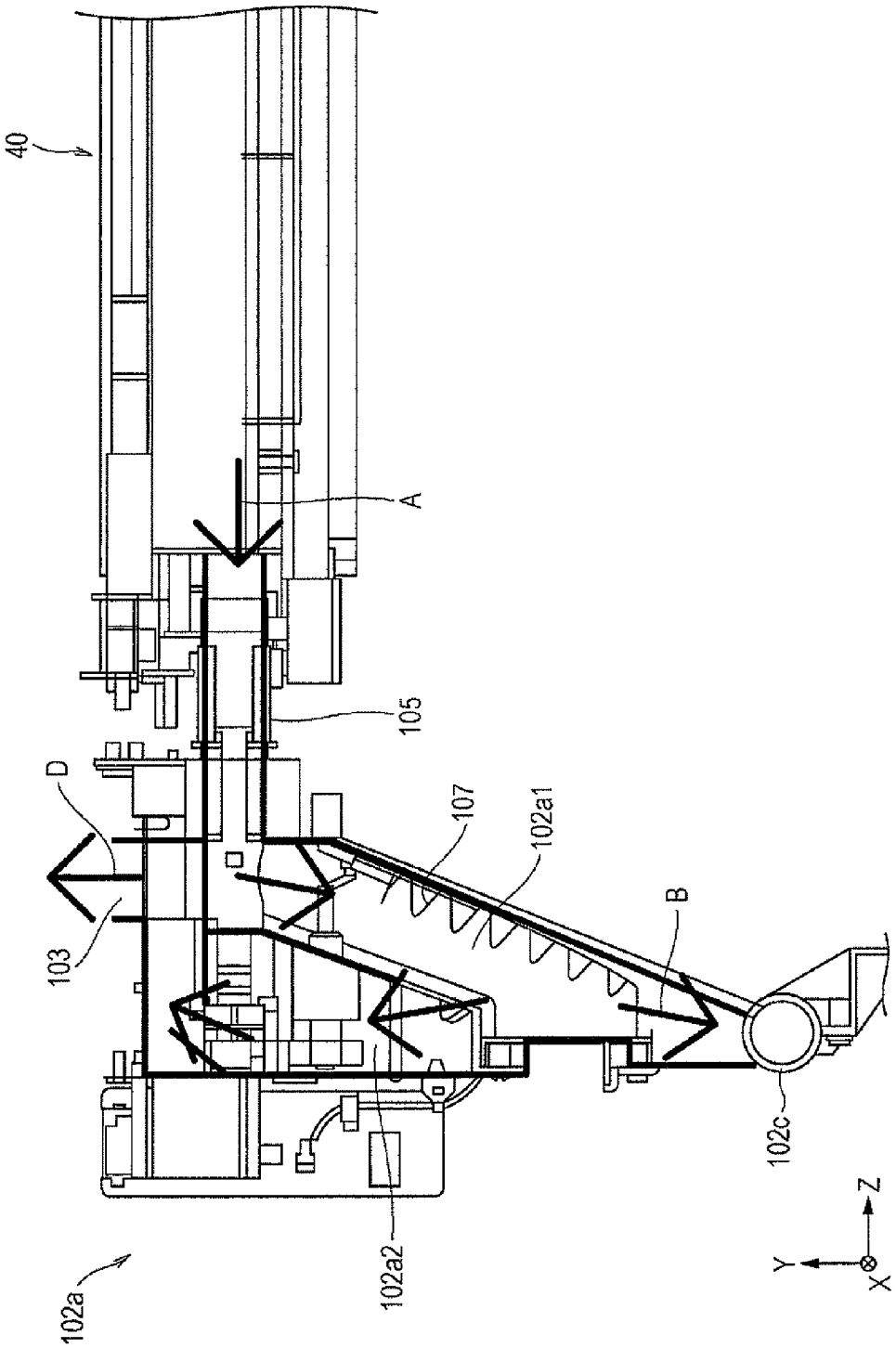


FIG. 10

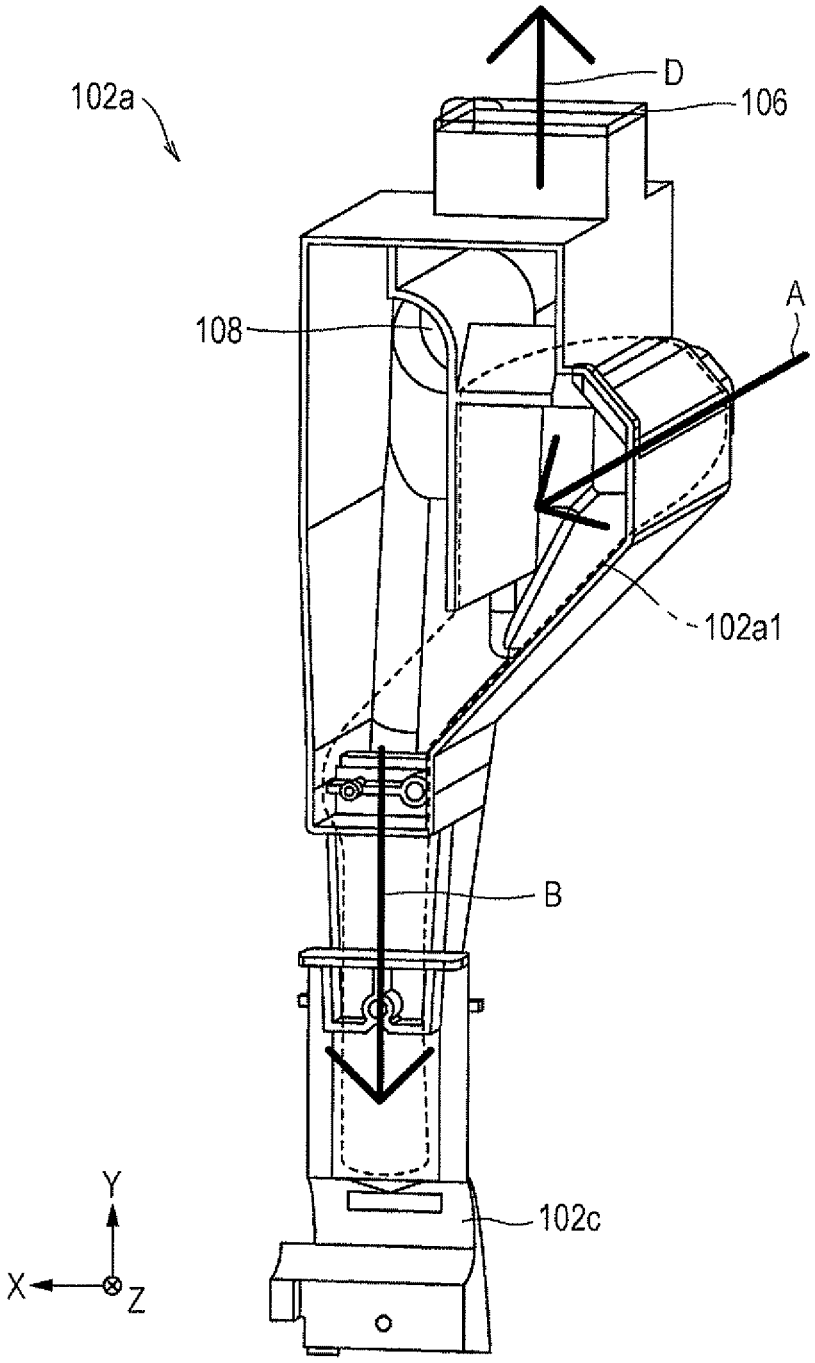


FIG. 11

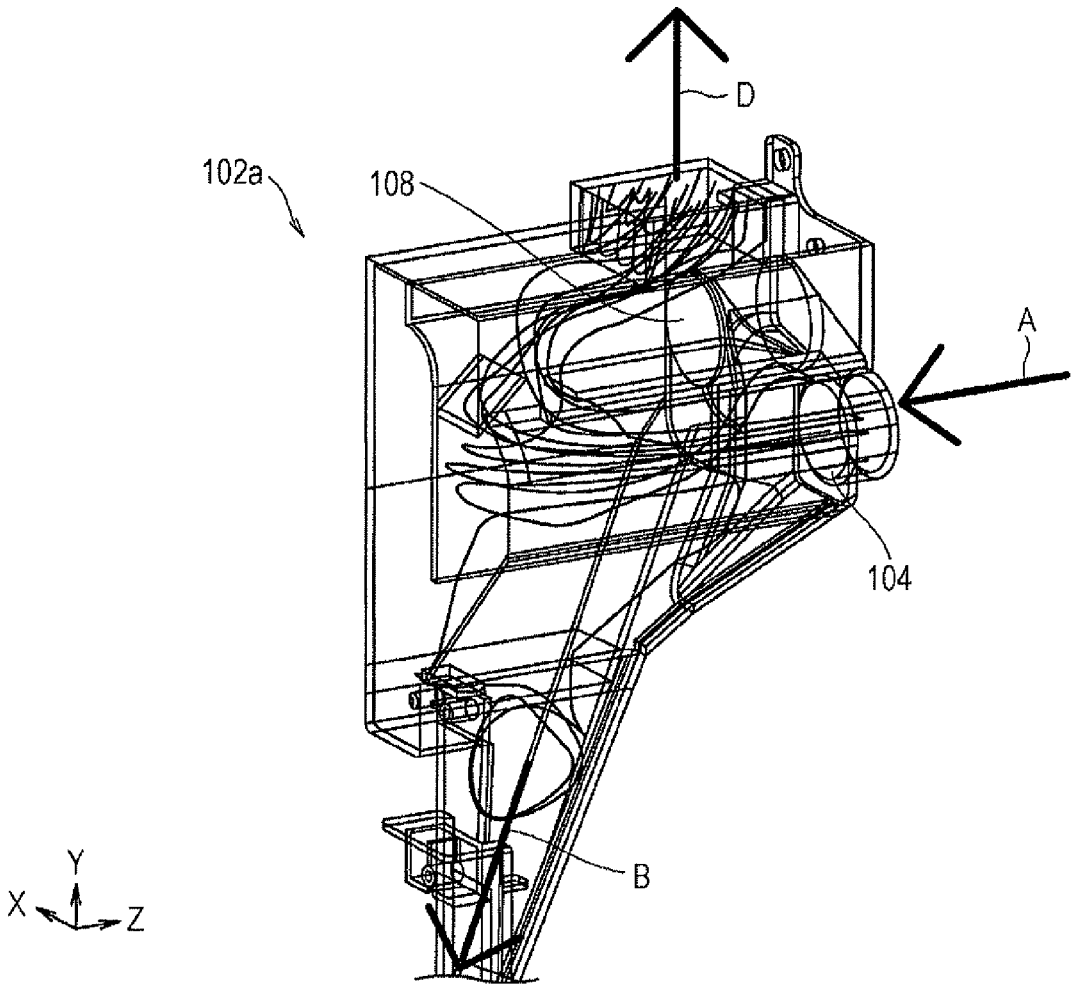


FIG. 12

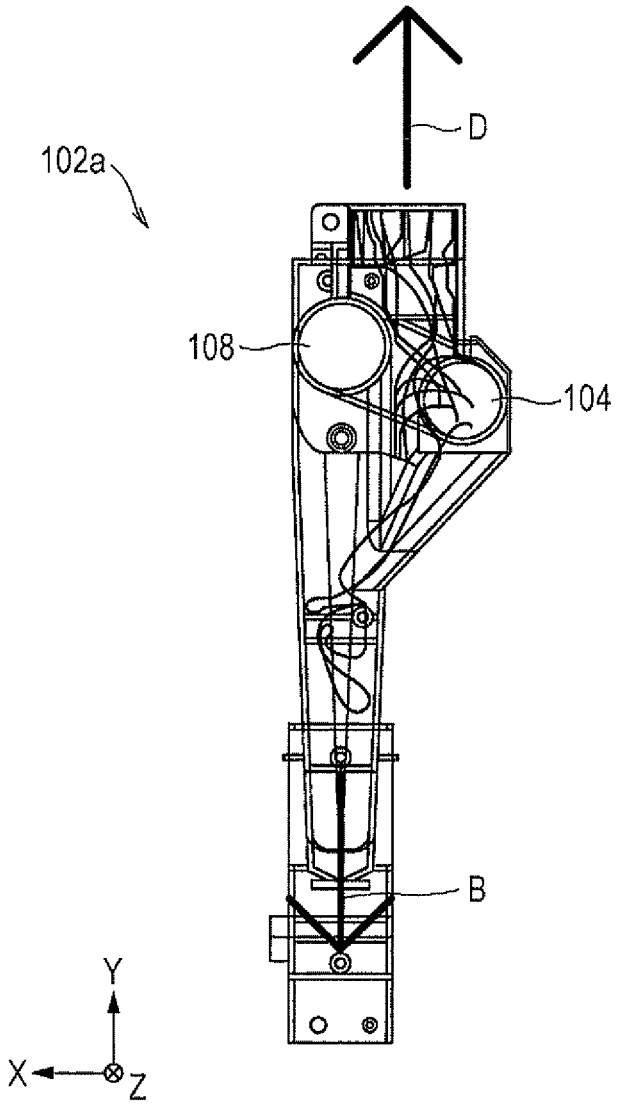
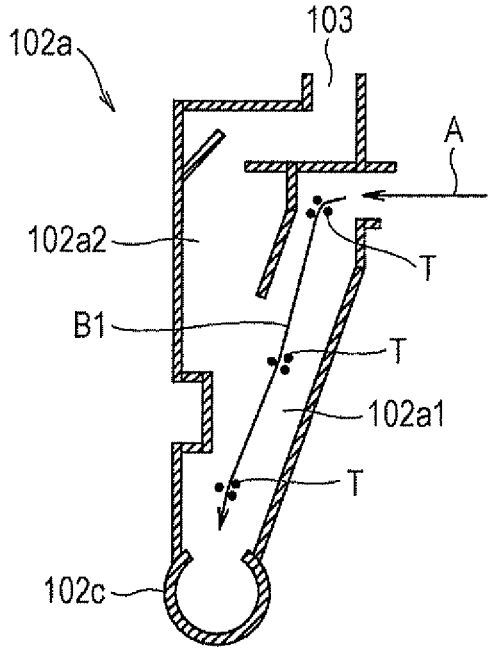


FIG. 13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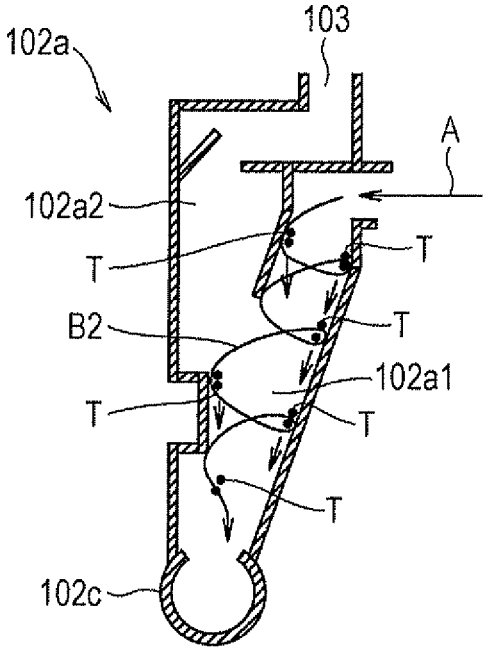
T
B1
T
102a1
T
102c

FIG. 14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102a2
T
T
T
B2
102a1
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T
102c

FIG. 15

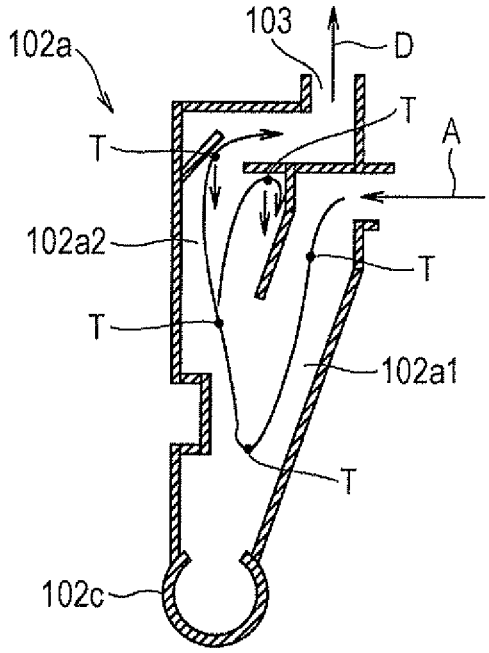


FIG. 16

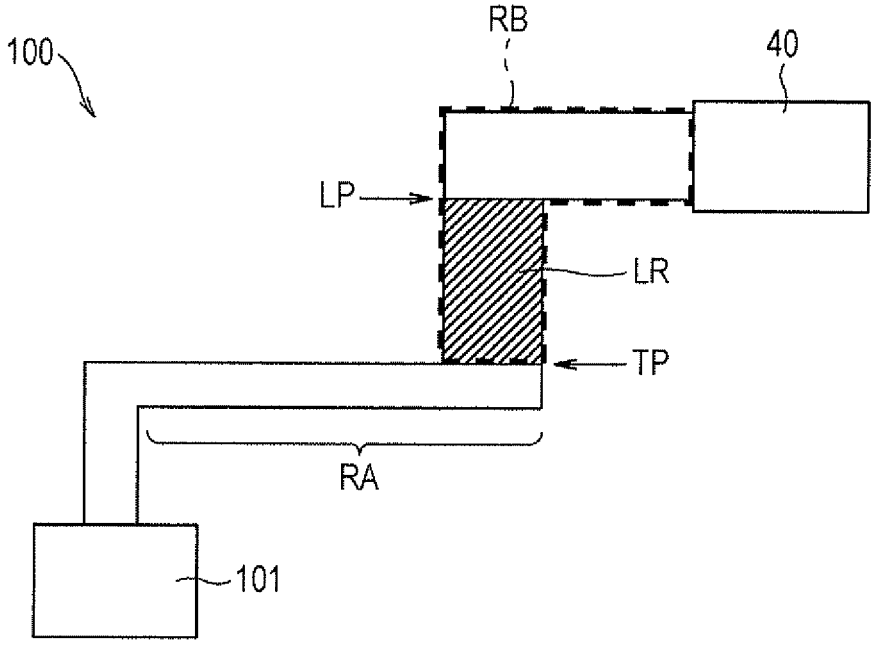
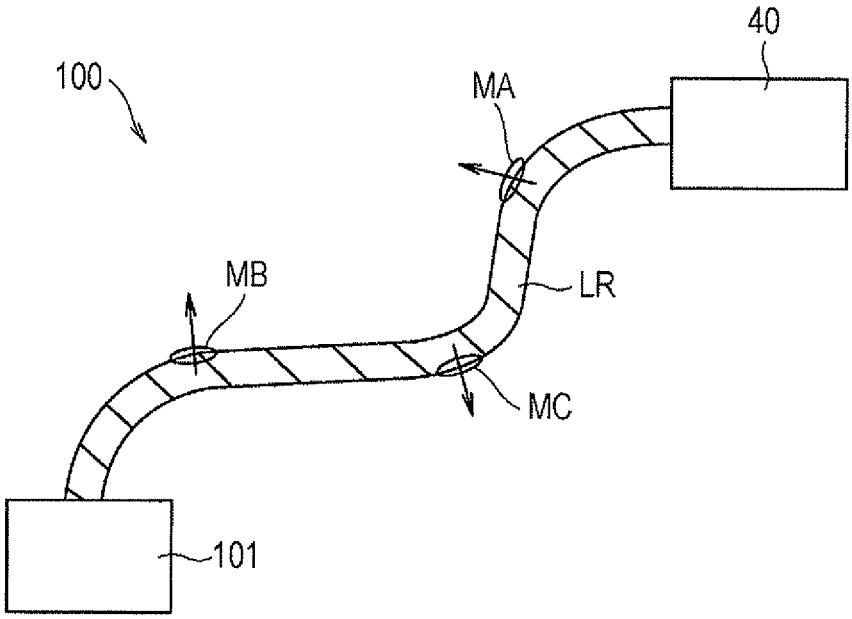


FIG. 17



WASTE-DEVELOPER COLLECTING DEVICE AND IMAGE FORMING APPARATUS INCLUDING THE WASTE-DEVELOPER COLLECTING DEVICE

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is based on and claims priority under 35 USC 119 from Japanese Patent Application No. 2013-066792 filed Mar. 27, 2013.

BACKGROUND

(i) Technical Field

The present invention relates to a waste-developer collecting device and an image forming apparatus including the waste-developer collecting device.

(ii) Related Art

Image forming apparatuses, such as a copying machine, a printer, a facsimile, apparatus, and an image forming apparatus having functions of these apparatuses, include an image forming apparatus that adopts an electrophotographic image forming system.

In an image forming technique using an electrophotographic image forming system, a toner image is formed by supplying toner from a developing device to an electrostatic latent image that is formed by irradiating a surface of a photoconductor drum with laser light, and is transferred onto a recording medium. Then, the transferred toner image is fixed on the recording medium by a fixing device.

When the processing speed of the image forming apparatus increases, the number of rotations of a developing roller in the developing device increases, and this increases the quantity of toner clouds.

SUMMARY

According to an aspect of the invention, there is provided a waste-developer collecting device including a developing device that develops a latent image with developer, a storage section that stores the developer transported from the developing device, and a path section extending from the developing device to the storage section, and including a downward path through which the developer in the developing device flows together with air in the developing device, the downward path guiding the flowing developer downward. An opening is provided on an upper side and an upstream side of a lowermost level of the downward path so that a part of the air flowing in the path section is released out through the opening.

BRIEF DESCRIPTION OF THE DRAWINGS

An exemplary embodiment of the present invention will be described in detail based on the following figures, wherein:

FIG. **1** is a schematic structural front view of an image forming apparatus according to an exemplary embodiment of the present invention;

FIG. **2** is a cross-sectional view of a developing device in the image forming apparatus of FIG. **1**;

FIG. **3** is a schematic structural rear view of the image forming apparatus of FIG. **1**;

FIG. **4** is an exploded perspective view of the image forming apparatus, illustrating a specific example of an internal rear section of the image forming apparatus of FIG. **3**;

FIG. **5** is an enlarged principal perspective view of a waste-toner collecting device in the image forming apparatus of FIG. **4**;

FIG. **6** is a partially cutaway principal perspective view of funnel units and the developing device in the waste-toner collecting device of FIG. **5**;

FIG. **7** is a partially cutaway principal perspective view of the funnel units and the developing device in the waste-toner collecting device of FIG. **5**;

FIG. **8** is a partially cutaway enlarged perspective view of the funnel unit of FIG. **5**;

FIG. **9** is a cross-sectional view taken along line IX-IX of FIG. **8**;

FIG. **10** is a cross-sectional view taken along line X-X of FIG. **8**;

FIG. **11** is a perspective view of the funnel unit, schematically illustrating flows of air and toner flowing from the developing device into the funnel unit of FIG. **8**;

FIG. **12** is a front view of the funnel unit, schematically illustrating flows of air and toner flowing from the developing device into the funnel unit of FIG. **8**:

FIG. **13** is a cross-sectional view of the funnel unit, taken along line XIII-XIII of FIG. **8**;

FIG. **14** is a cross-sectional view of the funnel unit, taken along line XIV-XIV of FIG. **8**;

FIG. **15** is a cross-sectional view of the funnel unit, taken along line XV-XV of FIG. **8**;

FIG. **16** is a schematic structural view of the waste-toner collecting device, illustrating an example of a downward path; and

FIG. **17** is a schematic structural view of the waste-toner collecting device, illustrating cases in which upward openings and an opening that is not an upward opening are provided.

DETAILED DESCRIPTION

An exemplary embodiment of the present invention will be described in detail below with reference to the drawings. In the drawings illustrating the exemplary embodiment, identical constituent elements are denoted by the same reference numerals in principle, and repetitive descriptions thereof are skipped.

FIG. **1** is a schematic structural front view of an image forming apparatus according to the exemplary embodiment. While a case using a monocomponent developer composed of toner to be fixed on a recording medium, such as a sheet of paper, will be described here for easy explanation, alternatively, a two-component developer in which carriers are mixed in toner may be used.

An image forming apparatus **1** according to the exemplary embodiment is a tandem color printer as an example, and includes plural image forming units **2** (**2***w*, **2***y*, **2***m*, **2***c*, and **2***k*), an intermediate transfer belt (an example of a receiving body) **3**, a belt cleaner **4**, a backup roller **5***a* and a second transfer roller **5***b* that form a pair, supply containers **6**, a transport system **7**, and a fixing device **8**.

The image forming units **2** include five color image forming units **2***w*, **2***y*, **2***m*, **2***c*, and **2***k* that form toner images, for example, of white, yellow, magenta, cyan, and black, and perform first transfer of images formed according to color image data onto the intermediate transfer belt **3**.

These five image forming units **2***w*, **2***y*, **2***m*, **2***c*, and **2***k* are arranged in a rotating direction of the intermediate transfer belt **3**, for example, in a color order of white, yellow, magenta, cyan, and black.

Each of the image forming units **2** includes a photoconductor drum (an example of an image carrier) **10**, a charging device **20**, an exposure device **30**, a developing device **40**, a first transfer roller (an example of a transfer part) **50**, and a drum cleaner **60**. The charging device **20** charges a surface of the photoconductor drum **10** to a predetermined potential. The exposure device **30** forms an electrostatic latent image by irradiating the photoconductor drum **10** with laser light LB. The developing device **40** forms a developed toner image by supplying toner onto the surface of the photoconductor drum **10** on which the electrostatic latent image is formed. The first transfer roller **50** transfers the toner image on the surface of the photoconductor drum **10** onto the intermediate transfer belt **3** at a first transfer position. The drum cleaner **60** removes residual toner and paper powder from the surface of the photoconductor drum **10** after the toner image is transferred.

Above each of the image forming units **2**, a toner cartridge **70** is provided as an example of a toner supply container that supplies color toner to the corresponding developing device **40**. In each of the image forming units **2**, the photoconductor drum **10**, the charging device **20**, the developing device **40**, and the drum cleaner **60** are mounted removably from the image forming apparatus **1**.

In each of the image forming units **2**, the first transfer roller **50** is provided such that the intermediate transfer belt **3** is held between the corresponding photoconductor drum **10** and the first transfer roller **50**. By applying a transfer bias voltage having a polarity reverse to a toner charging polarity to the first transfer roller **50**, an electric field is produced between the photoconductor drum **10** and the first transfer roller **50**, and toner charged on the photoconductor drum **10** is transferred onto the intermediate transfer belt **3** by the Coulomb force. The photoconductor drum **10** rotates clockwise during first transfer.

On the above-described intermediate transfer belt **3**, different color toner images formed by the image forming units **2** are sequentially transferred (first transfer) and held. The intermediate transfer belt **3** is wound in an endless form on plural support rollers **80***a*, **80***b*, **80***c*, **80***d*, **80***e*, and **80***f* and the backup roller **5***a*. While the intermediate transfer belt **3** is rotating counterclockwise, the toner images formed by the image forming units **2***w*, **2***y*, **2***m*, **2***c*, and **2***k* are first transferred onto the intermediate transfer belt **3**.

The above-described belt cleaner **4** removes and collects toner remaining on the intermediate transfer belt **3** after below-described second transfer performed by the backup roller **5***a* and the second transfer roller **5***b*.

The backup roller **5***a* and the second transfer roller **5***b* described above are paired to constitute a mechanism that collectively transfers (second transfer) multiple toner images transferred on the intermediate transfer belt **3** onto a recording medium, such as a sheet of paper, to form a full-color image. The backup roller **5***a* and the second transfer roller **5***b* are opposed to each other with the intermediate transfer belt **3** being disposed therebetween.

A position where the backup roller **5***a* and the second transfer roller **5***b* are opposed serves as a second transfer position. The backup roller **5***a* is rotatably provided on a back side of the intermediate transfer belt **3**, and the second transfer roller **5***b* is rotatably provided at a position opposed to a surface of the intermediate transfer belt **3** on which the toner images are transferred.

The toner images on the intermediate transfer belt **3** are transferred by applying a voltage of the same polarity as the toner charging polarity to the backup roller **5***a* or applying a voltage of a reverse polarity to the toner charging polarity to the second transfer roller **5***b*. Consequently, a transfer electric field is produced between the backup roller **5***a* and the second transfer roller **5***b*, and unfixed toner images held on the intermediate transfer belt **3** are transferred onto a sheet of paper or the like.

Each of the above-described supply containers **6** stores plural sheets. A sheet is drawn out of the supply container **6** by a pick-up roller (not illustrated) in the transport system **7**, and is then transported to registration rollers **7***r* through a transport path **7***a* in the transport system **7**. The registration rollers **7***r* control the timing at which the transported sheet is transported to the second transfer position.

After the toner images are transferred onto the sheet at the second transfer position, the sheet is transported to the fixing device **8** via transport belts **7***b* and **7***c* in the transport system **7**. The fixing device **8** fixes unfixed toner images transferred on the sheet by heat and pressure. The fixing device **8** of the exemplary embodiment includes a heating roller **8***a* and a pressurizing roller **8***b* that are opposed to each other across the transport path. Alternatively, the fixing device **8** may include the heating roller **8***a*, the pressurizing roller **8***b*, and a heating belt (not illustrated) that passes through a fixing nip between the heating roller **8***a* and the pressurizing roller **8***b*.

FIG. **2** is a cross-sectional view of each developing device **40** in the image forming apparatus of FIG. **1**.

Each developing device **40** includes a housing **41** functioning as a support frame. The housing **41** includes a toner storage section **41***a* that stores toner, and an open portion **41***b* provided at a position opposed to the photoconductor drum **10**. In the housing **41**, two developing rollers **42***a* and **42***b*, two toner transport members **43***a* and **43***b*, a layer-thickness regulation member **44**, a rotating transport body **45**, and a toner transport guide **46** are supported.

The developing rollers **42***a* and **42***b* develop a toner image with toner on the surface of the photoconductor drum **10**, and are arranged in an up-down direction in a state in which their outer peripheral surfaces are partially exposed from the open portion **41***b*. Rotation shafts of the developing rollers **42***a* and **42***b* are provided along a rotation shaft of the photoconductor drum **10**.

The outer peripheral surfaces of the developing rollers **42***a* and **42***b* are opposed to the outer peripheral surface of the photoconductor drum **10** with a gap therebetween, and toner is supplied from the developing rollers **42***a* and **42***b* to the photoconductor drum **10** through the opposed portion (a developing nip, a developing pole). The outer peripheral surfaces of the upper and lower developing rollers **42***a* and **42***b* are opposed to each other with a gap therebetween, and toner is supplied from the lower developing roller **42***a* to the upper developing roller **42***b* through the opposed portion.

The developing rollers **42***a* and **42***b* include magnet rollers **42***am* and **42***bm* and cylindrical sleeves **42***as* and **42***bs* provided on outer peripheries of the magnet rollers **42***am* and **42***bm*, respectively. The magnet rollers **42***am* and **42***bm* are fixed to and supported by the housing **41**, and the sleeves **42***as* and **42***bs* are supported rotatably along outer peripheral surfaces of the magnet rollers **42***am* and **42***bm*, respectively.

In the magnet rollers **42***am* and **42***bm*, plural magnetic poles (not illustrated) are magnetized in a circumferential direction. For example, the magnetic poles magnetized in the magnet rollers **42***am* and **42***bm* include an attraction pole for attracting toner, a transport pole for transporting the toner to an adjacent pole, a developing pole for supplying the toner onto the surface of the photoconductor drum **10**, and a separating pole for separating the toner. By these magnetic poles, the toner is delivered between the two developing rollers **42***a* and **42***b*, and is supplied to the photoconductor drum **10**. The magnetic poles are magnetized in a rotation axis direction of

the magnet rollers **42***am* and **42***bm* to form a magnetic field therearound at any position in the rotation axis direction.

The sleeves **42***as* and **42***bs* are formed of a nonmagnetic material such as aluminum, brass, stainless steel, or conductive resin. The sleeve **42***as* in the lower developing roller **42***a* rotates in the same direction as the rotating direction of the photoconductor drum **10** at a portion opposed to the photoconductor drum **10**, and the sleeve **42***bs* in the upper developing roller **42***b* rotates in a direction opposite to the rotating direction of the photoconductor drum **10** at a portion opposed to the photoconductor drum **10**.

The lower developing roller **42***a* is the last developing roller that supplies toner to the photoconductor drum **10**. For this reason, the amount of toner to be supplied to the photoconductor drum **10** is adjusted in the lower developing roller **42***a* so that a good image is formed on the photoconductor drum **10**.

At the open portion **41***b* of the housing **41**, a sealing roller **47** is provided between the two upper and lower developing rollers **42***a* and **42***b*. The sealing roller **47** seals a space between the developing rollers **42***a* and **42***b* so that the toner in the developing device **40** does not leak outside from between the developing rollers **42***a* and **42***b*. A rotation shaft of the sealing roller **47** is provided along the rotation shafts of the developing rollers **42***a* and **42***b*.

In the above-described toner storage section **41***a*, two toner storage regions **41***c* are arranged along each other with a partition wall **41***d* being disposed therebetween. The two toner storage regions **41***c* are connected via apertures (not illustrated) provided in the partition wall **41***d* at both longitudinal ends of the toner storage section **41***a*.

In the toner storage regions **41***c* of the toner storage section **41***a*, the above-described toner transport members **43***a* and **43***b* are provided rotatably. The toner transport members **43***a* and **43***b* transport toner in the toner storage regions **41***c* in the longitudinal direction of the toner storage section **41***a* while agitating the toner.

For example, spiral rotary blades are provided on outer peripheries of the toner transport members **43***a* and **43***b*. When the toner transport members **43***a* and **43***b* rotate, toner in the toner storage regions **41***c* is transported in opposite directions in the longitudinal direction of the toner storage section **41***a*. The toner in the toner storage regions **41***c* of the toner storage section **41***a* is delivered through the apertures provided in the partition wall **41***d* at both longitudinal ends of the toner storage section **41***a*, and circulates in the toner storage section **41***a*.

The toner transport member **43***b* on a transport downstream side, of the two toner transport members **43***a* and **43***b*, is opposed to the lower developing roller **42***a* with a gap therebetween, and toner is supplied from the toner transport member **43***b* to the lower developing roller **42***a* through the opposed portion.

The toner cartridge **70** (see FIG. **1**) is connected to a toner supply port (not illustrated) provided at a longitudinal end of the toner storage section **41***a* via a transport path, and toner (fresh toner) in the toner cartridge **70** is supplied into the toner storage section **41***a* through the toner supply port.

The above-described layer-thickness regulation member **44** is a plate-shaped member that regulates the thickness of a layer of toner transported from the toner transport member **43***b* to the developing rollers **42***a* and **42***b*. Toner delivered from the toner transport member **43***b* on the transport downstream side to the lower developing roller **42***a* is transported to the developing rollers **42***a* and **42***b* after the layer thickness thereof (toner amount) is regulated by the layer-thickness regulation member **44**, and is further transported to the portion opposed to the photoconductor drum **10** (developing nip, developing pole).

A distal end of the layer-thickness regulation member **44** is provided opposed to the outer periphery of the lower developing roller **42***a* with a gap corresponding to a predetermined toner layer thickness value therebetween. Toner is frictionally charged by the magnetic interaction between the distal end of the layer-thickness regulation member **44** and the magnet roller **42***am* of the lower developing roller **42***a*, is made into a thin layer, and is held on the surface of the sleeve **42***as* in the lower developing roller **42***a*.

The above-described rotating transport body **45** returns toner remaining on the upper developing roller **42***b* into the toner storage section **41***a*. The rotating transport body **45** is provided directly above a portion between the toner transport members **43***a* and **43***b* and adjacent to the layer-thickness regulation member **44**, and is rotatable clockwise. A rotation shaft **45***a* of the rotating transport body **45** is provided along the rotation shafts of the developing rollers **42***a* and **42***b* and the toner transport members **43***a* and **43***b*.

Four rotary blades **45***b* are provided on an outer periphery of the rotation shaft **45***a* of the rotating transport body **45**. The rotary blades **45***b* are each bent to have an L-shaped cross section so as to hold transported toner. By rotating the rotating transport body **45** at low speed, toner is accumulated in the rotating transport body **45**, so that the storage capacity of toner is increased without increasing the size of the developing device **40**.

The above-described toner transport guide **46** forms a path through which the toner remaining on the upper developing roller **42***b* is transported to the rotating transport body **45** and is returned into the toner storage section **41***a*. The toner transport guide **46** is provided between the upper developing roller **42***b* and the rotating transport body **45** and directly above the layer-thickness regulation member **44**, and slopes from the upper developing roller **42***b* toward the rotating transport body **45**.

The toner transport guide **46** is provided such that its longitudinal direction extends along the developing roller **42***b* and the rotation shaft **45***a* of the rotating transport body **45**. After development, the toner remaining on the upper developing roller **42***b* is transferred to the toner transport guide **46** by the repulsion force at the separation pole of the magnet roller **42***bm* and the rotational centrifugal force of the developing roller **42***b*, is transported to the rotating transport body **45** while sliding on a slope surface of the toner transport guide **46**.

FIG. **3** is a schematic structural rear view of the image forming apparatus of FIG. **1**, FIG. **4** is an exploded perspective view of the image forming apparatus, illustrating a specific example of an internal rear section of the image forming apparatus of FIG. **3**, and FIG. **5** is an enlarged principal perspective view of a waste-toner collecting device in the image forming apparatus of FIG. **4**. In the following drawings, coordinates x, Y, and Z are added for easy understanding of the positional relationship among the drawings.

The image forming apparatus **1** includes a waste-toner collecting device (an example of a waste-developer collecting device) **100** that collects waste toner produced in the image forming apparatus **1**.

The waste-toner collecting device **100** includes the plural developing devices **40** provided for the corresponding image forming units **2**, a waste-toner collecting container (an example of a storage section) **101** that collects toner, and a transport path section (an example of a path section) **102** connected between the developing devices **40** and the waste-

toner collecting container **101** to transport waste toner to the waste-toner collecting container **101**.

The transport path section **102** includes funnel units **102***a* and **102***b* and waste-toner collecting pipes **102***c*, **102***d*, **102***e*, and **102***f*.

Plural funnel units **102***a* are arranged in correspondence with the developing devices **40** in the image forming units **2**. The funnel units **102***a* are transport pipes having a function of transporting waste toner produced in the developing devices **40** to the waste-toner collecting container **101**. The funnel units **102***a* are connected to the corresponding developing devices **40**, and extend downward from the height of the developing devices **40** and are connected to the waste-toner collecting pipe **102***c*. As illustrated in FIG. **5**, upper surfaces of the funnel units **102***a* have depressurizing openings **103** through which the internal pressure is released from the developing devices **40**. As will be described below, the openings **103** communicate with the insides of the funnel units **102***a*. Further, below-described filters (not illustrated) are set at the openings **103** to close the openings **103**. The internal structure of the funnel units **102***a* will be described below.

The funnel unit **102***b* is provided in correspondence with the belt cleaner **4**. The funnel unit **102***b* is a transport pipe having a function of transporting toner collected by the belt cleaner **4** to the waste-toner collecting container **101**. The funnel unit **102***b* is connected to the belt cleaner **4**, and extends downward from the height of the belt cleaner **4** to be connected to the waste-toner collecting pipe **102***c*.

The waste-toner collecting pipe **102***c* extends in the direction in which the image forming units **2** are arranged, and is connected to the lower waste-toner collecting pipe **102***e* via the waste-toner collecting pipe **102***d* that is connected to a part of the waste-toner collecting pipe **102***c*. The waste-toner collecting pipe **102***e* extends in the direction in which the image forming units **2** are arranged, and is connected to the lower waste-toner collecting container **101** via the waste-toner collecting pipe **102***f* that is connected to a part of the waste-toner collecting pipe **102***e*.

FIGS. **6** and **7** are partially cutaway principal perspective views of the funnel units and the developing device in the waste-toner collecting device **100** of FIG. **5**. Arrow A represents a flow of air (including toner) flowing from the developing device **40** to the funnel unit **102***a*, arrow B represents a flow of waste toner in the funnel unit **102***a*, arrow C represents a flow of waste toner in the waste-toner collecting pipe **102***c*, and arrow D represents a flow of air for releasing the internal pressure of the developing device **40**.

As illustrated in FIG. **6**, a longitudinal end of one toner storage region **41***c* in the toner storage section **41***a* of the developing device **40** is connected to the funnel unit **102***a*. Since the pressure in the developing device **40** is higher than the pressure outside the image forming apparatus **1**, air containing waste toner flows from the inside of the developing device **40** into the funnel unit **102***a*, as shown by arrow A. The toner flowing in the funnel unit **102***a* is transported to the lower waste-toner collecting pipe **102***c* through the path in the funnel unit **102***a*, as shown by arrow B, and is further transported to the waste-toner collecting container **101** (see FIG. **3**), as shown by arrow C.

As illustrated in FIG. **7**, the space between the photoconductor drum **10** and the developing rollers **42***a* and **42***b* is connected to the funnel unit **102***a*. Since the pressure in the space between the photoconductor drum **10** and the developing rollers **42***a* and the developing roller **42***b* is also higher than the pressure outside the image forming apparatus **1**, air containing toner flows from the space into the funnel unit **102***a*. In this case, the toner flowing in the funnel unit **102***a* is also transported to the lower waste-toner collecting pipe **102***c* through the path in the funnel unit **102***a*, as shown by arrow B, and is further transported to the waste-toner collecting container **101**.

In contrast, as illustrated in FIGS. **6** and **7**, the air (containing toner) flowing from the inside of the developing device **40** and the space between the photoconductor drum **10** and the developing rollers **42***a* and **42***b* into the funnel unit **102***a* is released out of the image forming apparatus **1** from the depressurizing opening **103** provided on the upper surface of the funnel unit **102***a*, as shown by arrow D. A below-described filter (not illustrated in FIGS. **6** and **7**) is set at the opening **103**.

In this way, in the exemplary embodiment, the funnel unit **102***a* includes both the transport path for the toner from the inside of the developing device **40** and the transport path for the toner from the space between the photoconductor drum **10** and the developing rollers **42***a* and **42***b*.

As described above, the developing rollers **42***a* and **42***b* of the developing device **40** are rotated to supply toner to the photoconductor drum **10** in the image forming apparatus **1**. However, when an air current is produced by the rotation of the developing rollers **42***a* and **42***b* and air flows into the developing device **40**, toner in the developing device **40**, which is unlikely to be electrostatically confined, floats on the air current in the developing device **40**, and causes toner clouds. Since the processing speed of the image forming apparatus **1** has recently been increased, the number of rotations of the developing rollers **42***a* and **42***b* of the developing device **40** increases, and this increases the quantity of toner clouds.

In contrast, in the exemplary embodiment, air in the developing device **40** is released through the opening **103** of the funnel unit **102***a* included in the waste-toner collecting device **100**, and the internal pressure of the developing device **40** is thereby released. Thus, the pressure difference between the inside and the outside of the developing device **40** is less than in the structure in which the internal pressure is not released. When the pressure difference between the inside and the outside of the developing device is smaller, toner in the developing device is less likely to be released to the outside.

A depressurizing opening is sometimes provided in the housing **41** of the developing device **40**. In this case, however, since the opening is close to the toner storage regions **41***c*, the amount of toner that reaches the depressurizing opening increases. If a filter is set at the opening, it is clogged with toner. In contrast, in the exemplary embodiment, the opening **103** for depressurizing the developing device **40** is provided in the funnel unit **102***a* of the waste-toner collecting device **100** remote from the developing device **40**. Hence, the amount of toner that reaches the depressurizing opening **103** may be less than when the depressurizing opening is provided in the housing **41** of the developing device **40**.

FIG. **8** is a partially cutaway enlarged perspective view of the funnel unit **102***a* of FIG. **5**, FIG. **9** is a cross-sectional view, taken along line IX-IX of FIG. **8**, and FIG. **10** is a cross-sectional view, taken along line X-x of FIG. **8**. In FIG. **8**, the interior of the funnel unit **102***a* shows through for easy explanation.

The funnel unit **102***a* is hollow. The toner storage region **41***c* of the developing device **40** and the inside of the funnel unit **102***a* are connected to each other via an opening **104** (see FIG. **8**) provided in a side face of the funnel unit **102***a*. A seal member **105** (see FIG. **9**) is attached to a connecting portion between the developing device **40** and the funnel unit **102***a*. This may ensure higher airtightness than when a seal member

is not provided, and may restrict toner from leaking out from the connecting portion between the developing device **40** and the funnel unit **102***a*.

The funnel unit **102***a* includes a first path **102***a***1** extending downward (an example of a downward path) and a second path **102***a***2** branching off a part of the first path **102***a***1** and extending upward (an example of a branch path). The first path **102***a***1** refers to an area having a vertical component, of the transport path section **102**, and extends downward from the opening **104** and reaches the waste-toner collecting pipe **102***c*. Also, the first path **102***a***1** guides, to the lower waste-toner collecting pipe **102***c*, toner flowing from the developing device **40** into the funnel unit **102***a* through the opening **104** (see a portion enclosed by a broken line in FIG. **10**). Definitions of the downward path and the area having the vertical component illustrated by the first path **102***a***1** will be described below.

In contrast, the second path **102***a***2** extends upward from a middle portion of the first path **102***a***1** and reaches the depressurizing opening **103** provided thereabove. The second path **102***a***2** guides, to the opening **103**, air flowing from the developing device **40** into the funnel unit **102***a* through the opening **104**.

The opening **103** is provided on an upper side and an upstream side of a lowermost level of the first path **102***a***1** so that a part of air flowing in the transport path section **102** is released out of the transport path section **102**. Thus, in the structure for releasing air existing in the developing device **40** to the outside, compared with a case in which the opening **103** through which the air is released is provided in the developing device **40** and a case in which the opening **103** is provided on a downstream side or a lower side of the lowermost level of the first path **102***a***1**, the amount of toner that reaches the opening **103** together with the air when the air passes through the opening **103** is reduced. A direction on which the upstream and downstream sides are based is a moving direction of developer in the path that extends from the developing device **40** to the waste-toner collecting container **101** serving as an example of a storage section.

The opening **103** is provided above a branch position where the second path **102***a***2** branches off the first path **102***a***1**. Thus, compared with a case in which the opening **103** is not provided above the branch position, when air flowing from the developing device **40** passes through the opening **103**, the amount of developer that reaches the opening **103** together with the air is reduced.

The above-described filter **106** (see FIGS. **8** and **10**) is attached to the opening **103** to close the opening **103**. The filter **106** transmits air flowing in the second path **102***a***2**, but rarely transmits toner entering the second path **102***a***2**.

The above-described first path **102***a***1** is shaped like a funnel as an example. That is, the first path **102***a***1** has a portion whose cross-sectional area gradually decreases from an upper side toward a lower side. Thus, compared with a case in which the first path **102***a***1** does not have the portion whose cross-sectional area gradually decreases from the upper side toward the lower side, developer floating in the air that flows in the first path **102***a***1** falls more easily. Along the first path **102***a***1**, a coil-shaped member **107** (see FIG. **9**) is provided. The coil-shaped member **107** promotes falling of toner.

The above-described second path **102***a***2** includes a labyrinth-shaped path. That is, an inner face is provided between the opening **103** and an entrance of the second path **102***a***2** (a portion branching off the first path **102***a***1**). The inner face intersects an air flow direction flowing from the entrance of the second path **102***a***2** toward the opening **103**. When air flowing in the second path **102***a***2** strikes the inner face, the power of the air declines, and toner floating in the air flowing from the entrance of the second path **102***a***2** toward the opening **103** more easily falls than when the inner face is not provided.

The opening **103** is provided in the upper surface of the funnel unit **102***a*, and is formed as an upward opening. An upward opening refers to an opening such that a vector intersecting a virtual plane defined by a periphery of the opening at a right angle from the inner side of the path has an upward component. By making the opening **103** as an upward opening, compared with a case in which the opening from which air is released from the developing device **40** is not an upward opening, the amount of developer that reaches the opening **103** together with the air when the air passes through the opening **103** is reduced.

The first path **102***a***1** and the second path **102***a***2** are each surrounded by intersecting faces so that the cross-sectional shape taken along a plane intersecting the up-down direction is substantially rectangular. While the cross-sectional shape of the first path **102***a***1** and the second path **102***a***2** may be circular or elliptical, when it is substantially rectangular, air flowing along an inner wall surface of the funnel unit **102***a* and toner in the air easily strike the inner wall surface of the funnel unit **102***a*.

The space between the photoconductor drum **10** and the developing rollers **42***a* and **42***b* is also connected to the first path **102***a***1** and the second path **102***a***2** of the funnel unit **102***a* via an opening **108** (see FIGS. **8** and **10**). With this structure, toner, which flows from the space into the funnel unit **102***a* through the opening **108**, is transported to the waste-toner collecting pipe **102***c* through the first path **102***a***1** and is further transported to the waste-toner collecting container **101**.

In contrast, air flowing in the funnel unit **102***a* through the opening **108** flows to the depressurizing opening **103** through the second path **102***a***2**, and is released out of the image forming apparatus **1** via the filter **106**.

FIG. **11** is a perspective view of the funnel unit of FIG. **8**, schematically illustrating flows of air and toner flowing from the developing device into the funnel unit, and FIG. **12** is a front view of the funnel unit of FIG. **8**, schematically illustrating the flows of air and toner flowing from the developing device into the funnel unit. In FIGS. **11** and **12**, the interior of the funnel unit **102***a* shows through in order to illustrate the flows of air and toner.

Irregular lines in the funnel unit **102***a* represent flows of air and toner. FIGS. **13**, **14**, and **15** illustrate examples in which toner falls in the funnel unit **102***a*. FIGS. **13**, **14**, and **15** are cross-sectional views of the funnel unit **102***a*, taken along lines XIII-XIII, XIV-XIV, and XV-XV of FIG. **8**, respectively. In these figures, alphabet T represents toner.

As shown by arrow B**1** of FIG. **13**, a large part of (more than or equal to half of) toner T flowing into the funnel unit **102***a* together with air falls by gravity.

More than or equal to half of the remaining toner T flowing into the funnel unit **102***a* together with air strikes the inner wall surface of the funnel unit **102***a* on the air current. The toner T striking the inner wall surface loses momentum and falls by gravity. In the exemplary embodiment, when air flows from the developing device **40** into the funnel unit **102***a* via the side face of the funnel unit **102***a*, an air current is formed along the inner wall surface of the funnel unit **102***a*, as shown by arrow B**2** of FIG. **14**. Then, the toner T heavier than the air is separated toward the outer peripheral side of the air current, and strikes the inner wall surface of the funnel unit **102***a*. The toner T striking the inner wall surface loses momentum, and falls by gravity.

A part having a small particle diameter, of the remaining toner T flowing in the funnel unit **102***a*, sometimes flows into the second path **102***a***2** on the air current in the funnel unit **102***a*, as illustrated in FIG. **15**. However, the toner T flowing in the second path **102***a***2** strikes the wall surface of the second path **102***a***2** that forms a labyrinth. The toner T striking the wall surface loses momentum and falls by gravity.

In the exemplary embodiment, the downward path refers to a path into which developer flows together with air in the developing device and which guides the flowing developer downward. The downward path represents an area of the path section having a vertical component.

For example, when a path having no vertical component is provided on the upstream side, the area having the vertical component starts from a lower end (a side of the area having the vertical component) of a connecting portion to the path having no vertical component. For example, when the path having no vertical component is provided on the downstream side, the area having the vertical component ends at an upper end (a side of the area having the vertical component) of the connecting portion to the path having no vertical component. As described above, the direction on which the upstream and downstream sides are based is the moving direction of developer in the path from the developing device **40** toward the waste-toner collecting container **101**.

FIG. **16** is a schematic structural view of the waste-toner collecting device, illustrating an example of a downward path. In the exemplary embodiment, in the path from the developing device **40** to the waste-toner collecting container **101**, an area having a vertical component between a lower end LP of a connecting portion to the upstream developing device **40** and an upper end TP of a connecting portion to a downstream path RA having no vertical component is an example of a downward path LR. In FIG. **16**, the downward path LR is hatched for easy understanding of the figure. Also, a region enclosed by a broken line of FIG. **16** represents an example of a region RB on an upper side and an upstream side of a lowermost level of the downward path LR.

In the exemplary embodiment, the upward opening refers to an opening such that a vector perpendicularly intersecting a virtual plane defined by an outer periphery of the opening from the inner side of the path has an upward component. FIG. **17** is a schematic structural view of the waste-toner collecting device, illustrating an example in which upward openings and a different opening are provided. Openings MA and MB of the downward path LR in the path section between the developing device **40** and the waste-toner collecting container **101** are upward openings because vectors shown by arrows have upward components, but an opening MC is not an upward opening because a vector shown by arrow does not have an upward component. For easy understanding of the figure, the downward path LR is hatched.

The foregoing description of the exemplary embodiment of the present invention has been provided for the purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise forms disclosed. Obviously, many modifications and variations will be apparent to practitioners skilled in the art. The embodiment was chosen and described in order to best explain the principles of the invention and its practical applications, thereby enabling others skilled in the art to understand the invention for various embodiments and with the various modifications as are suited to the particular use contemplated. It is intended that the scope of the invention be defined by the following claims and their equivalents.

For example, in the exemplary embodiment, the present invention is applied to the intermediate transfer image forming apparatus in which an image transferred on the intermediate transfer belt is transferred onto a sheet of paper or the like. Alternatively, the exemplary embodiment may be applied to a direct-transfer image forming apparatus in which a toner image on a photoconductor drum is directly transferred onto a sheet of paper or the like.

While the present invention is applied to the image forming apparatus using color toners in the exemplary embodiment, it is not limited thereto. Alternatively, the present invention may be applied to an image forming apparatus using toner of a single color such as black.

While the developing device includes two developing rollers in the exemplary embodiment, the exemplary embodiment is not limited thereto. Alternatively, a developing device including only one developing roller may be used.

While the present invention is applied to the color printer in the exemplary embodiment, for example, it may be applied to other image forming apparatuses such as a color copying machine, a facsimile apparatus, or an image forming apparatus having both functions of these apparatuses.

What is claimed is:

1. A waste-developer collecting device comprising:

a developing device that develops a latent image with developer;

a storage section that stores the developer transported from the developing device; and

a path section extending from the developing device to the storage section, and including a downward path through which the developer in the developing device flows together with air in the developing device, the downward path guiding the flowing developer downward,

wherein an opening is provided on an upper side and an upstream side of a lowermost level of the downward path so that a part of the air flowing in the path section is released out through the opening.

2. The waste-developer collecting device according to claim **1**,

wherein the opening is an upward opening.

3. The waste-developer collecting device according to claim **1**,

wherein the path section further includes a branch path branching upward on the upper side and the upstream side of the lowermost level of the downward path, and

wherein the opening is provided in the branch path and above a branch position where the branch path branches.

4. The waste-developer collecting device according to claim **2**,

wherein the path section further includes a branch path branching upward on the upper side and the upstream side of the lowermost level of the downward path, and

wherein the opening is provided in the branch path and above a branch position where the branch path branches.

5. The waste-developer collecting device according to claim **3**,

wherein the branch path includes, between the branch position of the branch path and the opening, an inner face that intersects an air flow direction flowing into the branch path at the branch position.

6. The waste-developer collecting device according to claim **4**,

wherein the branch path includes, between the branch position of the branch path and the opening, an inner face that intersects an air flow direction flowing into the branch path at the branch position.

7. The waste-developer collecting device according to claim **1**,

wherein the downward path has a portion whose cross-sectional area decreases from an upper side toward a lower side.

8. The waste-developer collecting device according to claim **2**,

wherein the downward path has a portion whose cross-sectional area decreases from an upper side toward a lower side.

9. The waste-developer collecting device according to claim **3**,

wherein the downward path has a portion whose cross-sectional area decreases from an upper side toward a lower side.

10. The waste-developer collecting device according to claim **4**,

wherein the downward path has a portion whose cross-sectional area decreases from an upper side toward a lower side.

11. The waste-developer collecting device according to claim **5**,

wherein the downward path has a portion whose cross-sectional area decreases from an upper side toward a lower side.

12. The waste-developer collecting device according to claim **6**,

wherein the downward path has a portion whose cross-sectional area decreases from an upper side toward a lower side.

13. An image forming apparatus comprising:

the waste-developer collecting device according to claim **1**;

an image carrier that carries the latent image developed with the developer supplied from the developing device in the waste-developer collecting device; and

a transfer part that transfers the latent image on the image carrier onto a receiving body.

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